BlueFinder

Fall Quarter Design Review
Development Team

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Cynthia Alvarez-Preciado  Software Design, Fusion/UI
Eric Nystrom (Lead), James Cook, Chris Chan  CACI Mentors
Introduction

BlueFinder will locate Bluetooth devices using only information from the signals they emit.
Project Description

- Locate Bluetooth devices using software defined radios (SDR) programmed with direction-finding algorithms
- Display current location and location history on Android app in an easy-to-use interface
Why is this problem important?

- A Bluetooth solution for location tracking allows
  - Indoor localization of tracking devices where GPS struggles
  - Higher energy efficiency compared to Wi-fi tracking

- Examples
  - Security
  - Notifications
  - Ecommerce
Why is this problem important?

- Advantages: Low cost implementation and leverages existing Bluetooth technology in smartphones

- Disadvantages: Requires a Bluetooth device on each asset
- Uses XTRX and Jetson AGX Xavier
- Monitors the 2.4GHz band to find and store Bluetooth packets as it finds them
- We’re going to add location estimation for the detected devices
- PCB base to build upon
Angle of Arrival (AoA)

- Angle of arrival
  - Calculate the angle to the signal source using phase shift between the same signal received by two or more antennas (antenna array)

\[ \theta = \arcsin\left( \frac{c}{2\pi f} \cdot \frac{\Delta \varphi}{d} \right) \]

- The more antennas in an antenna array, the better the estimation.
Angle of Arrival (AoA)
Time Difference of Arrival (TDoA)

- Time difference of arrival
  - Calculate the distance to the signal source using the difference of time the same signal is received by two or more antennas
- Like GPS, three antennas required to determine location
Time Difference of Arrival (TDoA)
Combined

Angle + Distance = Location
AoA + TDoA
PCB

- 8 layers, 7” x 7”
- Our plans:
  - Update schematics
    - PCIe mini
    - HDMI
    - Ethernet/RJ45
  - Add a second PCIe mini port for a second XTRX
  - Additional goals
    - Make board more compact
    - Add a third XTRX
XTRX

- Software Defined Radio
  - Used to capture the Bluetooth signals
  - Can be programmed to pick up packets from the 2.4GHz spectrum
- PCIe connection - PCB/Jetson Xavier
- We will be using at least two XTRX
- Each XTRX will have 2 antennas
Jetson AGX Xavier

- PCIe connection to XTRX
- GPU for signal processing
  - Speeds up DSP calculations
- We’re using the dev-board version to develop and test software
STM32L4R5 Microcontroller

● Similar to the STM32L476VGT6 we used in 153B
  ○ The ...76VGT6 from 153B belongs to the STM32L4 series
  ○ The ...76VGT6 in our project belongs to the STM32L4+ series
    ■ Higher clock speeds, more memory

● Used for power-up sequencing and power management
Critical Goals

● The most important goal is to have a machine that locates Bluetooth devices using two XTRX
● We have a professional and useable UI to convey the information to the user
● Update the existing PCB, software, etc.
● We make optimizations after the core functionality is working robustly
● Finally, small improvements and add-ons
Schedule Fall quarter

- Hardware
  - Learn Altium through sponsor mentor instruction + 2 week online course
  - Go over PCIe, HDMI, RJ45 specification to revise associated designs
  - By end of quarter
    - schematics finished
    - BOM sent in to CACI
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● Software
  ○ Learn CUDA coding
  ○ Understand the BlueDentist software
  ○ Implement AoA/TDoA
Schedule Winter quarter

● Hardware
  ○ First five weeks is PCB layout design
    ■ Adding 2nd XTRX (“the hardest part”)
    ■ Making board smaller
    ■ Adding extra features
  ○ Next few weeks is verifying layout
  ○ Inflexible deadline: submit gerber files to CACI by week 8 to have PCB manufactured
  ○ Last two weeks work on firmware

● Software
  ○ Adjust processing step for direction finding
  ○ Implement comms to send data to Fusion/UI
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Questions?